GUFT Conservation Principles: Formalizing Trimm's Axiom and DEQF Pressure Coherence

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Abstract

We formalize conservation principles implied by the Grand Unified Field Theory of Asymmetry (GUFT), with a focus on the Trimm Conservation Axiom (TCA) and its implications for energy, information, and baryon conservation. These emerge from the static pressure coherence of the Dark Energy Quantum Field (DEQF), offering a unified physical origin for c, Λ, and decoherence thresholds. We derive conditions under which conservation holds or fails, propose field equations for the coherence tensor $\kappa_{\mu\nu}(t)$, and outline experimental paths for testing violations. This framework integrates and extends the implications of GUFT, making novel predictions for cosmology, gravitation, and quantum information.

1 Introduction

Conservation laws are cornerstones of modern physics. In standard frameworks, Noether's Theorem connects symmetries of the action to conserved quantities. Standard decoherence theory—especially as formulated by Zurek—describes how environmental entanglement suppresses interference terms, yielding classical pointer states [**?**]. However, such models do not explain why one outcome is selected; they describe how possibilities fade, not how one becomes real. GUFT proposes a deeper origin: conservation arises only under coherence in the pressure field of the Dark Energy Quantum Field (DEQF), and collapse is the resolution of constrained routing under that pressure.

This paper introduces the Trimm Conservation Axiom (TCA) and explores its role in collapse dynamics, conservation structure, and phase coherence. We build on earlier GUFT work concerning the roles of c and Λ, and show how TCA links coherence, pressure, and outcome selection.

Standard interpretations of decoherence, notably those advanced by Zurek, describe the emergence of classicality through the suppression of interference terms due to environmental entanglement. These models succeed in explaining why superpositions are not observed at

macroscopic scales but stop short of specifying how a single outcome is selected. GUFT extends this framework by assigning ontological status to coherence itself, treating it as a conserved and re-routable quantity subject to pressure dynamics within the DEQF. This allows collapse to be treated not as a projection or a loss of information, but as a continuity-preserving realignment of coherence in accordance with conservation constraints.

We term this process coherence minimization under constraint—a signature principle of GUFT. Rather than allowing coherence to simply dissipate, GUFT posits that collapse occurs through a pressure-governed redistribution that minimizes coherence subject to strict conservation rules. This constrained minimization governs which outcomes are physically permitted and how decoherence proceeds in interaction with the DEQF. It is not an arbitrary collapse but a deterministic consequence of field coherence and conservation geometry. In contrast to standard decoherence models, which leave the emergence of classicality conceptually vague, GUFT defines a precise boundary: classicality emerges at the coherence-saturation surface, where causal decoherence has exhausted all conservation-permissible routing options.

In GUFT, a coherence domain is a bounded region of spacetime across which coherence may be redistributed without violating global conservation. These domains evolve dynamically under $\kappa(t)$, and collapse is triggered when coherence can no longer be rerouted internally without breaching the divergence-free condition. This geometric constraint replaces the vague "environment" of standard decoherence with a sharply defined physical structure.

This perspective clarifies why wavefunction collapse [1] appears probabilistic: from the inside, decoherence looks statistical because we lack knowledge of the global coherence geometry. But from the outside, GUFT collapse is deterministic—it reflects a unique, coherence-minimizing redistribution constrained by conservation geometry in $\kappa(t)$. The probabilities of quantum mechanics emerge as a thermodynamic shadow of this deeper coherence routing process.

This mechanism departs sharply from Born-rule indeterminism. In GUFT, apparent randomness emerges not from intrinsic quantum unpredictability, but from our ignorance of the dynamic coherence geometry embedded in the DEQF. Collapse is an expression of spacetime structure under conservation constraint, not an arbitrary selection from a probability cloud. Thus, GUFT replaces ontological randomness with geometric necessity. In contrast to GRW-style spontaneous collapse theories, no stochastic modification of unitary evolution is required.

A core insight developed here is that coherence behaves not as a passive probabilistic wavefunction amplitude, but as a quantity dynamically constrained by conservation laws. Collapse emerges through **coherence minimization under constraint**, a signature GUFT principle. In this view, the DEQF enforces conservation not by forbidding violations, but by routing coherence through regions of allowed pressure. Measurement is the physical expression of this routing, where coherence is minimized in a way that preserves global continuity and local balance. This bridges the gap between entropic decoherence models and ontologically grounded collapse.

In this view, decoherence is not a perspectival illusion arising from entanglement with an external environment, but a geometric constraint internal to the system, independent of

[1] In GUFT, "collapse" refers not to an instantaneous wavefunction reduction, but to a constrained redistribution of coherence amplitude across the DEQF field, governed by conservation-compatible pathways.

any observer.

2 The Trimm Conservation Axiom

We formalize the Trimm Conservation Axiom (TCA):

> **TCA:** Conservation of energy, information, and baryon number is not an inviolable law, but a phase-dependent emergent condition. It holds if and only if $\nabla \cdot \kappa = 0$, where κ is the DEQF pressure coherence tensor.

This axiom not only explains the collapse mechanism but also yields a predictive framework: measurement events should correlate with abrupt changes in $\kappa(t)$, observable in principle through coherence-sensitive detectors or deviations from unitary evolution in controlled systems. In this view, measurement is not an external imposition but an intrinsic phase shift in the DEQF-coherence structure.

3 DEQF Pressure and Coherence Tensor

In GUFT, the DEQF underlies spacetime as a dynamic but quantized pressure field. Its coherence governs the rate of decoherence $\Theta(t)$, the emergence of c, and the value of Λ.

We define a second-rank symmetric pressure coherence tensor, $\kappa_{\mu\nu}(t)$, representing the DEQF pressure field constrained by causal coherence domains—regions of spacetime within which coherence can be routed without violation of conservation laws. This tensor captures not only the field's internal alignment but also the dynamic pathways available for coherence redistribution. When $\nabla \cdot \kappa = 0$, conservation laws hold and unitary evolution proceeds. When $\nabla \cdot \kappa \neq 0$, coherence becomes topologically unstable, triggering collapse through constrained minimization. Thus, $\kappa_{\mu\nu}$ functions as the ontological bridge between coherence, causality, and measurement.

$$\kappa_{\mu\nu}(t) \equiv \langle P_{\mu\nu} \rangle_{\text{coh}} \tag{1}$$

This tensor encodes the statistical coherence of vacuum pressure fluctuations along different worldlines. Conservation is preserved if and only if:

$$\nabla^{\mu} \kappa_{\mu\nu}(t) = 0 \tag{2}$$

Violations ($\nabla \cdot \kappa \neq 0$) indicate entropy injection, symmetry breaking, or quantum-to-classical transition events.

4 Coherence Timescale $\tau(t)$ and its Microphysical Origin

The coherence timescale $\tau(t)$ in GUFT represents the local duration over which quantum phase information remains accessible to the global DEQF (Dark Energy Quantum

Field). Formally, $\tau(t)$ may be interpreted as the **autocorrelation time** of vacuum fluctuations—specifically the persistence duration of off-diagonal density matrix elements before decoherence becomes irreversible.

At the microphysical level, we propose that $\tau(t)$ reflects the correlation interval over which virtual gravitons—transient distortions in the DEQF—remain phase-coherent across spacetime patches. As such, it may be defined via a two-point correlation function:

$$\tau(t) = \int_0^\infty \langle \delta g_{\mu\nu}(x,t)\, \delta g^{\mu\nu}(x, t+\Delta t) \rangle \, d(\Delta t)$$

where $\delta g_{\mu\nu}$ represents the metric fluctuations induced by quantum vacuum modes.

In this view, $\tau(t)$ is **not constant**, but dynamically evolves based on entropy density, decoherence state, and cosmic expansion. A sharp decrease in $\tau(t)$ signals the transition from coherent, entangled branches to classicalized outcomes—pinpointing when collapse must occur under conservation constraints.

5 Mathematical Formalization

To model the persistence of conservation influence across decohered branches, we introduce an influence kernel $I(x,t)$, representing the memory effect of conserved quantities across spacetime. This kernel maps the residual coherence pressure from past light cones into current measurement contexts.

Alternatively, a rank-2 *conservation transfer tensor* $C_{\mu\nu}(x,t)$ may be defined to represent how conservation constraints are projected forward through decoherence boundaries.

Both $I(x,t)$ and $C_{\mu\nu}(x,t)$ may be expressed as functions of the coherence timescale $\tau(t)$ or coupled to the gravitational coherence tensor $\kappa_g(t)$, integrating them directly into the dynamical structure of GUFT.

6 Experimental Implications

This coherence-constrained framework offers potential experimental signatures:

- **Phase memory in quantum erasure**: Delayed-choice erasure experiments could reveal non-local coherence routing preserved by the influence kernel.
- **Non-Gaussian noise**: Interference patterns or decoherence noise may exhibit structured deviations if influence leakage from nearby conservation minima is occurring.
- **Anomalous correlations**: Precision tests of Bell-type systems might detect deviations from standard predictions in regimes of gravitational coherence transition.

These predictions, while subtle, offer testable departures from standard interpretations and may distinguish GUFT experimentally.

7 Relation to Other Interpretations

GUFT departs from major interpretations in its treatment of collapse:

- **Bohmian Mechanics:** Posits hidden variables and pilot waves, but lacks a conservation-based collapse trigger.
- **Many-Worlds:** Retains all branches, denying collapse entirely; GUFT restores unique outcomes through conservation minimization.
- **Objective Collapse:** Invokes stochastic terms or mass thresholds; GUFT requires neither randomness nor mass-dependence, but relies on deterministic geometry.

Unlike these views, GUFT frames collapse as a deterministic consequence of global coherence routing and conservation geometry.

8 Entropy and the Arrow of Time

GUFT implies that while coherence routing is microscopically reversible under pressure conservation, the global evolution of decoherence creates an emergent arrow of time. This arrow emerges not from intrinsic entropy growth but from irreversible routing minima.

Thus, entropy in GUFT reflects an accumulation of coherence decisions that, while individually constrained, generate macroscopically asymmetric structure. In this framework, the second law of thermodynamics arises as a geometric statistical tendency within conservation-preserving spacetime routing.

9 Expansion of the Conservation Framework

9.1 Explicit Form of $\kappa_{\mu\nu}(t)$

We postulate the form:

$$\kappa_{\mu\nu}(t) = f(t) \cdot \eta_{\mu\nu} + \delta\kappa_{\mu\nu}(x,t) \tag{3}$$

Where $f(t)$ encodes background coherence and $\delta\kappa$ encodes local perturbations, such as curvature or particle interactions.

9.2 Lagrangian Coupling

To fully integrate this into GUFT's action principle, we define an effective Lagrangian term:

$$\mathcal{L}_\kappa = \frac{1}{2} M_P^{-2} \kappa^{\mu\nu}(t) T_{\mu\nu} \tag{4}$$

This term enforces dynamic coupling between DEQF pressure coherence and local energy-momentum.

9.3 Gauge Symmetry

A conjecture: DEQF coherence enforces global gauge conservation. Breakdown in κ may correspond to localized anomalies in $SU(3)$, $SU(2)$, or $U(1)$ gauge sectors.

9.4 Threshold Mapping

Define phase regions:

- $\nabla \cdot \kappa = 0$: conservation phase (classical GR, QFT)
- $\nabla \cdot \kappa \neq 0$: transition phase (inflation, black hole horizons, quantum collapse)

Map $\Theta(t)$ versus curvature, entropy density, or entanglement entropy to locate thresholds.

10 Coherence Tensor $C_{\mu\nu}(t)$

10.1 Evolution Equations

We propose a wave-like evolution:

$$\Box C_{\mu\nu}(t) + m_c^2 C_{\mu\nu}(t) = S_{\mu\nu}(x,t) \tag{5}$$

where $S_{\mu\nu}$ is a source term based on graviton density, entropy gradients, or curvature invariants.

10.2 Field Interactions

We include cross-terms in the full action:

$$\mathcal{L}_{\text{int}} = g_1 C^{\mu\nu} h_{\mu\nu} + g_2 C^{\mu\nu} F_{\mu\nu} + g_3 C^{\mu\nu} D_\mu \phi D_\nu \phi \tag{6}$$

where $h_{\mu\nu}$ is the metric perturbation, $F_{\mu\nu}$ gauge field strength, and ϕ the Higgs.

10.3 Experimental Probes

- CMB anomalies in polarization or tensor modes near reionization epoch
- Coherence loss in superconducting quantum systems
- Black hole horizon decoherence signatures

10.4 GR Compatibility

In the low-curvature limit:

$$\nabla_\mu T^{\mu\nu} = -\nabla_\mu \kappa^{\mu\nu} \to 0 \tag{7}$$

recovering standard conservation in GR.

11 Conclusion

We have presented a formal expression of the Trimm Conservation Axiom within GUFT and derived associated tensor frameworks. These provide theoretical tools for predicting where conservation laws may break down, guiding both high-energy physics and cosmological observations.

Appendix: Glossary of Axioms and Conservation Laws

- **Trimm Conservation Axiom**: Collapse must preserve all global conservation laws; measurement is constrained by conservation geometry.
- **Measurement Conservation Axiom**: No local measurement may violate the global coherence balance dictated by the DEQF.
- **Decoherence Routing Principle**: Among all decoherent branches, only the one minimizing global coherence strain (subject to conservation) actualizes.
- **Pressure Coherence Tensor** $\kappa_{\mu\nu}(t)$: Encodes coherence potential of the DEQF constrained by causal geometry.

References

The current formulation is built upon the foundational GUFT papers:

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